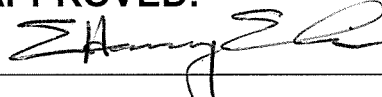


**SAN FRANCISCO PUBLIC UTILITIES COMMISSION  
WATER SYSTEM IMPROVEMENT PROGRAM  
CONSTRUCTION MANAGEMENT PROCEDURES**

**SECTION: WSIP CONSTRUCTION  
MANAGEMENT**

**APPROVED:**



**PROCEDURE NO.: 039  
TITLE: SYSTEM TESTING AND  
START-UP**

**DATE: 08/24/09**

**REVISION: 1**

**1.0 Policy**

The two major areas of particular importance for facility testing and start-up process are;

- Reliability and integrity of the water (pipeline) transmission system,
- Reliability and operations of the communications, data transmission, power, instrumentation and control systems.

This CM Procedure focuses on pre-testing, training, testing and start-up of the communications, data transmission, power, instrumentation and control systems, after the completion and acceptance of mechanical and pipe installation tests.

This CM Procedure applies to all personnel working on the Water System Improvement Program (WSIP) to the extent that their Work is affected by these WSIP Construction Management (CM) Procedures and does not conflict with specific San Francisco Public Utilities Commission (SFPUC) Policies or the Contract under which the Work is executed.

**2.0 Description**

This CM Procedure defines the tasks, requirements, sequence and responsibilities for execution of system testing and start-up of a new system or facility during the construction phase of the WSIP Program.

This CM Procedure also describes how issues identified during the process will be managed and resolved. It will be necessary to adapt this procedure to the actual scope and content of each project. This is particularly important when the system consists of multiple facilities linked by remote telemetry and controls that must operate in an integrated manner. The facility shutdown process detail description is provided in CM Procedure No. 022, System Shutdown.

## **2.1 Testing and Start-up Sequencing**

A typical facility testing and start-up process consists of the following sequential activities:

- Pre-Start-up Coordination Meeting,
- Field and Shop Mechanical and Piping Inspections,
- Functional Testing for components, subsystems and systems,
- Communication System Functional Tests for SCADA,
- Performance Test for subsystems and systems,
- Control System Functional Tests,
- Pre-Start-up Test activities,
- System Disinfection (sequence to be confirmed),
- Start-up Test activities,
- Performance Run,
- Post-Performance Run, corrective actions if required.

## **3.0 Definitions**

### **3.1 Construction Management Information System (CMIS)**

The WSIP CMIS is an on-line management tool for processing of contract documents based on established construction management business processes. It serves as a tool for effective storage and retrieval of various documents generated during a construction period.

### **3.2 Control Systems Functional Acceptance Test (FAT)**

The Control Systems FAT demonstrates the proper interaction of the facility Programmable Logic Controller (PLC) and the related equipment individual control system.

3.2.1 The System Integrator (SI) will be responsible for this test.

3.2.2 The Contractor Test Coordinator shall coordinate tests and activities to support the control system FAT.

### **3.3 Electrical Testing (ET) Firm**

The ET Firm is the testing entity responsible for performing functional and performance tests on all Division 16 Electrical equipment, components and materials.

3.3.1 The ET Firm shall coordinate scheduling work, testing, training of SFPUC personnel, and documentation with the Contractor Testing Coordinator.

### **3.4 Field Tests**

The Field Tests denotes all field testing including functional, performance, pre-start-up and start-up tests.

### **3.5 Functional Test**

The Functional Testing is required to determine, if installed equipment or system will operate in a satisfactory manner and as specified.

3.5.1 The Functional Test is a point-by-point test to confirm that all components associated with the equipment or systems are operating properly. All non-operating adjustments, cold alignment checks and/or cleaning shall be completed prior to Functional Test.

### **3.6 In-Factory Tests and Source Inspections**

The In-Factory Tests and Source Inspections are the verifications that specific equipment components conform to the performance criteria specified in the Contract Documents. In-Factory and Source Inspections occur before the equipment is delivered to the construction site.

3.6.1 Prior to delivery of equipment to the work site, it may have been designated for independent Third Party Supplier Quality Surveillance (SQS) activities. If SQS exceptions were accepted by SFPUC until equipment delivery and installation, then these exceptions must be tested for compliance during component testing. The equipment SQS Reports (with exceptions) are distributed to the Project CM, Project Engineer and Program QA Manager.

### **3.7 Performance Test**

The Performance Test is the field test required to demonstrate the individual equipment or system meets all of the contract performance requirements. Successful Performance Testing is a requirement of Substantial Completion.

3.7.1 After equipment or system start-up, another Performance Run will be conducted for the entire facility in compliance with contract documents.

### **3.8 Pre-Start-Up Test**

A Pre-Start-Up Test is a test of all systems operating together to demonstrate satisfactory performance of the facility as a whole, as it performs connected to the SFPUC system, for the specified Pre-Start-Up Test period without failure and to the satisfaction of the Contractor and the SFPUC.

3.8.1 The test procedures for both the Pre-Start-Up Test and Start-Up Test shall be the same. Any Start-Up Test requirement applies to the Pre-Start-Up Test. The Pre-Start-Up phase allows the Contractor to make final adjustments and troubleshooting before

Start-Up Testing. Successful completion of Pre-Start-Up Test shall ensure that the Contractor is ready to demonstrate satisfactory operational performance of the facility as a whole.

### **3.9 Supervisory Control and Data Acquisition (SCADA)**

3.9.1 The SCADA is a supervisory control system that monitors and coordinates the process.

3.9.2 The Remote Terminal Units (RTUs) are subsystems connecting to sensors in the process, converting sensor signals to digital data and sending digital data to the supervisory system.

### **3.10 Start-Up Test**

The Start-Up Test is the final commissioning test of all systems operating together to demonstrate satisfactory performance of the facility as a whole, as it performs connected to the SFPUC system, for the specified Start-Up Test period, without failure and to the satisfaction of the SFPUC.

### **3.11 Test Procedures**

The test procedures shall include testing methods, acceptance criteria, procedures, component testing, sub-system testing, performance testing and test data forms for functional performance and start-up tests.

3.11.1 If any portion of a test fails, the Contractor shall correct the problem and repeat the test to the satisfaction of the Quality Assurance (QA) Inspectors.

3.11.2 If any component or system failure occurs during Pre-Start-Up or Start-up Testing, then the entire test protocol shall be restarted.

3.11.3 After the completion of the Start-Up testing, the test data forms should be bound and turned over to facility Operations & Maintenance Department for future reference.

## **4.0 Responsibilities**

A typical System Testing and Start-up Team Organization, including direct lines of communication, field communication/coordination and “as needed” support are presented on Attachment 39 – 1.

### **4.1 Project Construction Manager (Project CM)**

The Project CM, with assistance from the CM Team, is responsible for reviewing the testing and startup requirements included in the Contract Documents for each project.

4.1.1 Testing and Start-Up Team direct reports to Project CM are;

- Project Engineer,
- ITS / SCADA Specialist,

- Electrical, Instrumentation & Controls QA Inspectors,
- Mechanical QA Inspectors,
- CM Consultant Test & Start-up Engineers,
- CM Consultant Electrical & Mechanical QA Inspectors (as needed).

#### **4.2 Project Engineer (PE)**

The SFPUC PE, in collaboration with the Operations Representative (OR), is responsible for defining the testing, start-up and commissioning requirements to be included in each construction contract.

4.2.1 The PE provides the interface with the Engineer of Record (EOR) who develops the engineering design and contract requirements. The PE may be the EOR in some cases.

4.2.2 The PE reports to the Project CM during facility testing, start-up and commissioning activities.

4.2.3 The EMB Design Engineers report to and provide support to the Project Engineering.

#### **4.3 CM Test & Start-Up Engineers (T&SE) – CM Team**

4.3.1 The T&SE report to the Project CM and functions as the project interface with SFPUC Operations for the City's responsibilities during project testing, training, commissioning, start-up and acceptance activities.

4.3.2 The Project CM designates one T&SE personnel as the responsible "lead" that coordinates the field activities with the Contractor Testing Coordinator.

4.3.3 The T&SE reviews and accepts the Contractor's test and start-up plans on behalf of the Project CM and coordinates with SFPUC Operations to minimize impacts to existing operating facilities and systems.

#### **4.4 Quality Assurance (QA) Inspectors – CM Team**

4.4.1 On each project, one QA Inspector will be designated a "Lead" QA Inspector for the project team to assist the Project CM in planning for and coordinating all QA inspection activities. The Lead QA Inspector is responsible for compiling reviewing and approving all Daily Inspection Reports.

4.4.2 The QA inspectors assure that the construction work is performed and completed in accordance with the Contract Documents; conduct periodic observation and inspection of the work, monitor Contractor's quality progress, coordinate field sampling and verification testing for quality.

4.4.3 The various specialty discipline QA Inspectors will be assigned as needed for the specific work activities to assist with start-up and commissioning activities. Specific QA Inspector needs for facility start-up may include mechanical, communications, electrical, control systems and instrumentation expertise.

#### **4.5 Electrical Testing (ET) Firm – Contractor**

4.5.1 The ET Firm is the independent third-party testing organization responsible for performing functional and performance test on all Division 16 Electrical equipment, components and materials.

4.5.2 The ET Firm is a Sub-Consultant provided by the Contractor and works directly with the Contractor Test Coordinator.

#### **4.6 System Integrator (SI) - Contractor**

4.6.1 The SI is the responsible party for interfacing the facility Programmable Logic Controller (PLC) and Controls to the Local Operator Interface (LOI) and the SFPUC's established San Francisco Water Department (SFWD) Supervisory Control and Data Acquisition (SCADA) System.

4.6.2 The SI duties include, but not limited to, performing all work necessary to design, select, furnish, customize, debug, supervise installation, connect, calibrate, field modify existing control and instrumentation wirings and place into operation all hardware, communication lines and equipment, and coordinate the programming of all software.

4.6.3 The SI provides the "As-Built" Programmable Logic documentation to the Project CM.

4.6.4 In most cases the SFPUC SCADA System will be programmed by the City. However, there may be circumstances where the Contractor will be requested to provide additional support services. The SI shall coordinate scheduling of work, testing, training of City personnel, and documentation with the Contractor Testing Coordinator.

4.6.5 The SI is provided by the Contractor and reports to the Contractor Test Coordinator.

#### **4.7 Contractor**

4.7.1 The Contractor is responsible for developing and submitting proposed test procedures, test schedules and Facility Testing and Start-Up Plan in accordance with the Contract, refer to Attachment 039 - 4.

4.7.2 Depending on the extent of the work and the requirements of the contract, the Contractor may be required to provide a full-time Contractor Test Coordinator, SI and ET Firm to prepare plans,

accomplish the test and commissioning work and submit testing reports.

4.7.3 The Contractor Test Coordinator is the Contractor lead for the facility start-up and commissioning activities and coordinates the activities with the Project CM or designated Lead Test & Start-up Engineer.

4.7.4 The Contractor shall make the Electrical Sub-Contractor available as part of the facility start-up team to perform corrective actions.

#### **4.8 Contractor Test Coordinator**

4.8.1 The Contractor Test Coordinator is a testing and commissioning expert responsible for organizing, assembling, compiling, and administering the functional, performance, and start-up test program for the overall project.

4.8.2 The Contractor Test Coordinator is responsible lead for the Contractor testing and commissioning activities.

#### **4.9 Communications / SCADA Specialist - Contractor**

The Contractor Communications / SCADA Specialist coordinates and performs all contract work associated or connected to the SFWD SCADA with the ITS / SCADA Coordinator.

#### **4.10 ITS / SCADA Specialist - City**

The ITS / SCADA Coordinator coordinates all work associated or connected to the SFPUC SCADA system with the Communications / SCADA Specialist for the Contractor. The ITS / SCADA Specialist completes all final connections to SCADA system.

#### **4.11 Operations Representative (OR)**

4.11.1 The OR assists the facility testing and start-up team and coordinates the activities of the Operating Divisions.

4.11.2 The OR is responsible to coordinate the activities of the Operations Disinfectant Team and the Project CM Team. The Operations Disinfectant Team implements the method and parameters specified by the Water Quality Bureau.

4.11.3 The OR participates on facility "Punch List" inspection, facility acceptance and closeout activities.

#### **4.12 Water Quality (WQ) Representative**

4.12.1 The Water Quality Representative coordinates the activities of the Water Quality Bureau with the Project CM Team.

4.12.2 The Water Quality Bureau collects water samples, runs water quality tests and certifies water test results to the Project CM Team.

4.12.3 The Water Quality Bureau Representative is responsible to prepare and provide the project disinfection method to the Project CM; and provide oversight for implementation by Operations personnel, refer to Technical Specification No. 01565, Sanitary Work Practices and Disinfection.

#### **4.13 EMB Design Engineers - City**

The SFPUC Engineering Management Bureau (EMB) Design Engineers shall provide field support as determined by Project CM and Project Engineer relevant to each project. Design Engineering support can include witness testing, reviewing field calculations or responding to technical Requests for Information.

### **5.0 Implementation**

The overall procedure for system testing and startup is defined by the activities described below and as shown in Attachment 39-2.

#### **5.1 Submittals**

5.1.1 The Contractor provides and enters all the contract construction submittals into the CMIS including;

5.1.1.1 Confirmation of submittal requirements from vendors and Electrical subcontractor.

5.1.1.2 List of all in-factory and source testing.

5.1.1.3 Proposed Testing personnel and firms' qualifications.

5.1.1.4 Manufacturer's representative qualifications and scope.

5.1.1.5 Test procedures for all field tests.

5.1.1.6 Facility Testing and Start-Up Plan based on project technical specifications, refer to Attachment 039 – 4.

5.1.1.7 Comprehensive Testing Schedules for Functional Testing, Performance Testing, Pre-Start-up Testing, Start-up Testing and Performance Run.

5.1.2 Submittal approval process: The Project CM is responsible for distributing the submittals to the PE, and T&SE ; all of whom shall review and comment within a reasonable period, or, if applicable, within the time specified in the contract. All review comments will be returned to the Project CM.

5.1.3 The Contractor shall provide missing submittals or resubmit corrections to the Project CM.

5.1.4 System Testing, Start-up and Post Performance Run submittals and records summary are presented in Attachment 39 – 3. The



summary list does not indicate every test data submittal required as required in each equipment or item project technical specification.

## **5.2 Orientation and Planning Meetings**

5.2.1 The Project CM schedules orientation and planning meetings for the Start-up Team;

- City Personnel: Project CM, PE, ITS/SCADA Specialist, Instrumentation & Controls QA Inspector, OR and WQ Representative.
- CM Consultant Personnel: Test & Start-up Lead, Test & Start-up Engineer(s), Electrical and Mechanical QA Inspectors.
- Contractor Personnel: Contractor Test Coordinator, Electrical Testing Firm, System Integrator, Communications/SCADA Specialist, and Electrical Subcontractor.

The actual composition of the Testing and Start-Up Team will be based on specific project needs.

5.2.2 Items for discussion: The purpose of the orientation and planning meetings are to clarify the terms of the contract, to discuss the development of test plans, sequence and timing of tests and to introduce team members and identify their respective roles and responsibilities.

5.2.2.1 Agreement for the removal of Lock-out / Tag-out barriers to safely energize the electrical systems, refer to Section 5.12.

5.2.2.2 The Project Engineer will confirm if supplier quality surveillance exceptions were accepted at the equipment supplier fabrication facility. The Project CM upon consultation with Regional CM if additional surveillance are necessary .

5.2.3 Facility Disinfection: Project CM, Operations Representative and Water Quality Representative will decide when and where to implement facility disinfection, if required, refer to Technical Specification No. 01565, Sanitary Work Practices and Disinfection.

## **5.3 Mechanical and Piping Inspections and Tests**

5.3.1 Roles and Responsibilities: The Contractor Test Coordinator shall lead the equipment and piping inspection and testing activities with assistance from the CM testing and start-up engineers, if required.

5.3.2 The Contractor shall perform mechanical inspection and testing process in accordance with the project technical specifications and manufacturer's recommended practice.

- 5.3.3 The Contractor shall perform piping system inspections and testing process in accordance with project technical specifications.
  - 5.3.3.1 The Contractor Test Coordinator shall arrange for the use of hydrostatic pressure test water through the T& SE Lead. The T&SE Lead coordinates with the OR.
- 5.3.4 CM Witness and Documentation: Field tests shall be witnessed and documented by Quality Assurance inspectors and others as specified in Technical Specification No. 01400.

#### **5.4 Functional Tests**

- 5.4.1 Roles and Responsibilities: The Contractor Test Coordinator shall lead Functional Test activities with assistance from the CM testing and start-up engineers, if required.
- 5.4.2 Contractor submittals: Interconnection and Loop Diagrams, Factory Tests, Manufacturer's Certificate of Installation, Component System Tests, Spare Parts and Draft Operations & Maintenance Manuals.
- 5.4.3 Functional Testing: Functional Testing is the verification that each component is in compliance with the Contract Documents. These tests may include Communications, Calibrations, Loop Checks, Electrical Commissioning, Installation Checks, Operations Check, Controls Checks, Alarm Checks, Run Checks and special test checks.
- 5.4.4 Contractor Test Coordinator confirms performance of installed components.
- 5.4.5 CM Witness and Documentation: Functional Tests shall be witnessed and documented by QA Inspectors.

#### **5.5 Communication System Functional Test (for SCADA)**

- 5.5.1 Roles and Responsibilities: The Contractor Test Coordinator is responsible for coordinating the Communications System Contractor, SI and independent ET Firm to test the fiber optic communications to the RTUs and fiber optic or microwave communications to the existing SFPUC network.
- 5.5.2 Test Requirements: All communication systems test requirements are provided in Division 13 Technical Specifications.
- 5.5.3 Facility Telecommunications: The SF Department of Telecommunications and Information System (DTIS) is responsible for the installation of equipment and cable and the testing, service, documentation and operational acceptance of the facility telecommunication system. The Project CM coordinates the contract work associated with the installation of conduit and other communication related facilities with DTIS.

5.5.4 CM Witness and Documentation: ITS/SCADA personnel, QA Inspector and OR verify proper installation of all communication systems.

## **5.6 Performance Test Requirements**

5.6.1 Roles and responsibilities: The Contractor Test Coordinator shall lead Performance Test Requirements activities with assistance from the CM testing and start-up engineers, if required.

5.6.2 Prerequisites and Documentation: Prior to Performance Tests, Contractor provides completed factory and field functional test of electrical component results.

5.6.3 Performance Tests: Verification of work functions as defined by the Contract documents.

5.6.4 CM Witness and Documentation: Witness and documented by Lead T&SE and QA Inspectors.

## **5.7 Control System Functional Acceptance Test (FAT)**

5.7.1 Roles and Responsibilities: The Contractor Test Coordinator is responsible for coordinating the Control System Functional Acceptance Test with Instrumentation and Electrical Subcontractor, Independent Electrical Testing Firm, Electrical Quality Assurance Inspector and other designated SFPUC personnel.

5.7.2 Test requirements: Contractor Test Coordinator conducts a formal FAT's to demonstrate proper performance of each process sub-system control modes from all interface locations prior to energizing or operating major systems components.

5.7.3 CM Witness and Documentation: Witness and documented by QA Inspectors and other designated personnel.

## **5.8 Pre-Start-Up Test**

5.8.1 Roles and Responsibilities: The Contractor Test Coordinator shall lead the Pre-Start Up activities with assistance from the CM testing and start-up engineers, if required.

5.8.2 Prerequisites and Submittals Review: Prior to Pre-Start-Up demonstration, Contractor completes and submits; all factory test records, draft Operations & Maintenance Manuals, all facility equipment and lines tagged and labeled, current As-Built Drawings submitted and Start-Up Test procedure approved.

5.8.3 City Personnel Training: All City operations and maintenance personnel shall be instructed on facility equipment and system and documented, refer to Section 5.13 for details.

- 5.8.4 Systems Tests: Pre-Start-Up Test duration shall be five (5) consecutive days without failure. The Project CM may vary the duration according to the complexity of the system test.
- 5.8.5 Witness and Documentation: Witness by Lead T&SE, QA Inspectors, Project CM, and other designated project stakeholders.

## **5.9 Start-Up Run**

- 5.9.1 Roles and responsibilities: The Contractor Test Coordinator shall lead the Pre-Start Up activities with assistance from the CM Testing and Start-Up Engineers, if required.
- 5.9.2 Prerequisite: Completion and acceptance of corrective actions discovered during Pre-Start-Up Test Run, completion of system disinfection.
- 5.9.3 Start-Up Process: The approved Start-Up Plan developed by the PE shall be implemented and lead by the Contractor Test Coordinator and T&SE.
- 5.9.4 CM Witness and Documentation: Witness and documented by QA Inspectors, Project CM, OR, PE and other designated project stakeholders.

## **5.10 Performance Run**

- 5.10.1 Roles and Responsibilities: The Contractor Test Coordinator, CM T&SE, PE and Project CM Team shall perform the final commissioning.
- 5.10.2 Prerequisite: Successful completion of Start-Up activities.
- 5.10.3 Performance Run: Performance Run is the verification step that the complete work functions on an extended basis as defined in scope and duration by the Contract Documents. Successful performance testing is a requirement of Substantial Completion.
- 5.10.4 CM Witness and Documentation: All facility functions are completed and witness tested per plan during final commissioning.
- 5.10.5 Facility Substantial Completion: Full operation of all components and systems of the work, including acceptance of all testing and start-up requirements.

## **5.11 Post-Performance Run**

- 5.11.1 Correct All Deficiencies: Contractor shall correct all facility deficiencies discovered during Performance Run period to the acceptance of Project CM.
- 5.11.2 Facility Restoration: After successful completion of Facility Performance Run, the Contractor shall remove all temporary equipment and return facility to normal design configuration.

5.11.3 Remaining Documentation: All remaining or revised contract submittal documents shall be provided to Project CM including final “As-Built” Drawings, “As-Built” Programmable Logic, Final Operations & Maintenance Manuals and Warranties.

5.11.4 Facility Turnover: After successful Performance Testing, submittal of all outstanding documents and clean-up/restoration, the facility shall be turned over to SFPUC Operating Division.

5.11.5 Proceed to Project Closeout Phase: The Project CM assisted by the PE will proceed to lead the project completion and closeout activities.

## **5.12 Lock-out / Tag-out**

As part of system start-up, the Project CM, OR and Contractor shall follow the Lock-out / Tag-out removal process as defined in Attachment 039 – 3, SFPUC Lock-out / Tag-out Program, April 21, 1998.

## **5.13 City Personnel Training**

Prior to Pre-Start-up Test activities, all equipment training of City Personnel shall be provided in accordance with the individual technical specifications.

5.13.1 Contractor shall submit names and qualifications of individual trainers for approval by Project CM.

5.13.2 Contractor shall submit list of operational training topics and session durations for approval by Project CM.

Facility training session topics may include:

- Functional Testing,
- Performance Testing,
- Major Equipment Operations, Maintenance and Safe Practice,
- Review of Equipment Operations & Maintenance information including Data Sheets and recommended spare parts list.

5.13.3 SFPUC Engineering Management Bureau is responsible to compile information, provide process description and procedure for the Facility Operations and Maintenance Manuals for City furnished equipment. Information which may be used in Contractor Training Sessions are:

- Facility Process Description – What it does and How it works,
- Facility Background – Explanation of systems and components,
- Facility Normal Operation, Normal Shutdown, Emergency Shutdown, Start-up Modes.

## **6.0 Other Procedural Requirements**

The following activities are not specific to the subject CM procedure, but are necessary to complete the testing and start-up process:

WSIP CM Procedure No. 004      Submittals

WSIP CM Procedure No. 033      As-Built Drawings

## **7.0 References**

### **7.1 Technical Specifications & Other Documents**

No. 01400: Quality Control

No. 01565      Sanitary Work Practices and Disinfection

No. 01660: Testing Coordination and System Start-Up Testing

No. 01730: Operations and Maintenance Data

No. 01750: Manufacturer's and Contractor's Service

### **7.2 CM Procedures**

No. 007      Daily QA Inspection Reports

No. 011      Construction Quality Management

No. 022      System Shutdowns

No. 026      SQS Plan and Surveillance Process

No. 030      Project History / Lesson Learned

No. 032      Contract Closeout (Substantial & Final Completion Certificate)

### **7.3 Other References**

SFPUC Lock-out / Tag-out Program, April 21, 1998

Lockout / Tag-out, OSHA Title 29. CFR Part 1910.147

## **8.0 Attachments**

039 - 1      Typical System Testing and Start-Up Team Organization  
(City / CM Consultant / Contractor)

039 - 2      Typical System Testing and Start-Up Flow Diagram

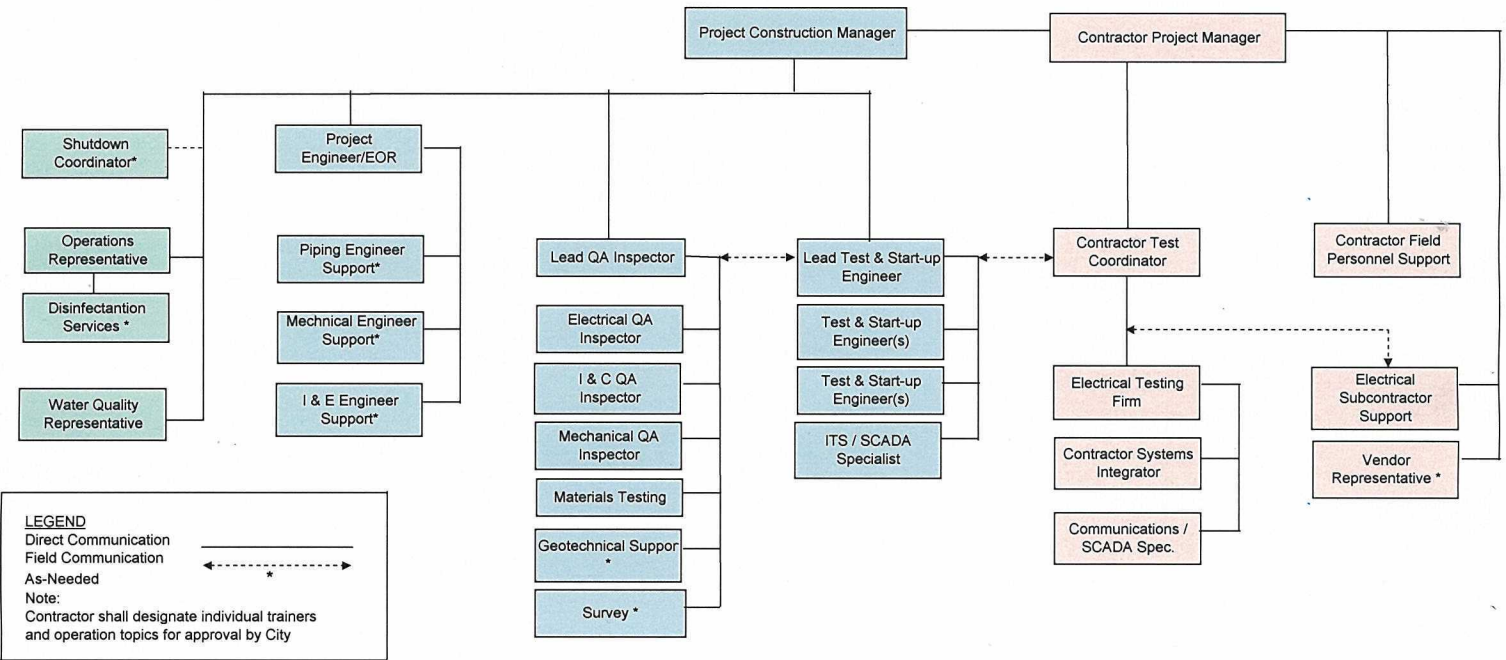
039 - 3      Testing and Start-Up Submittal Forms and Records Summary

039 - 4      Facility Testing and Start-Up Plan – Table of Contents Sample

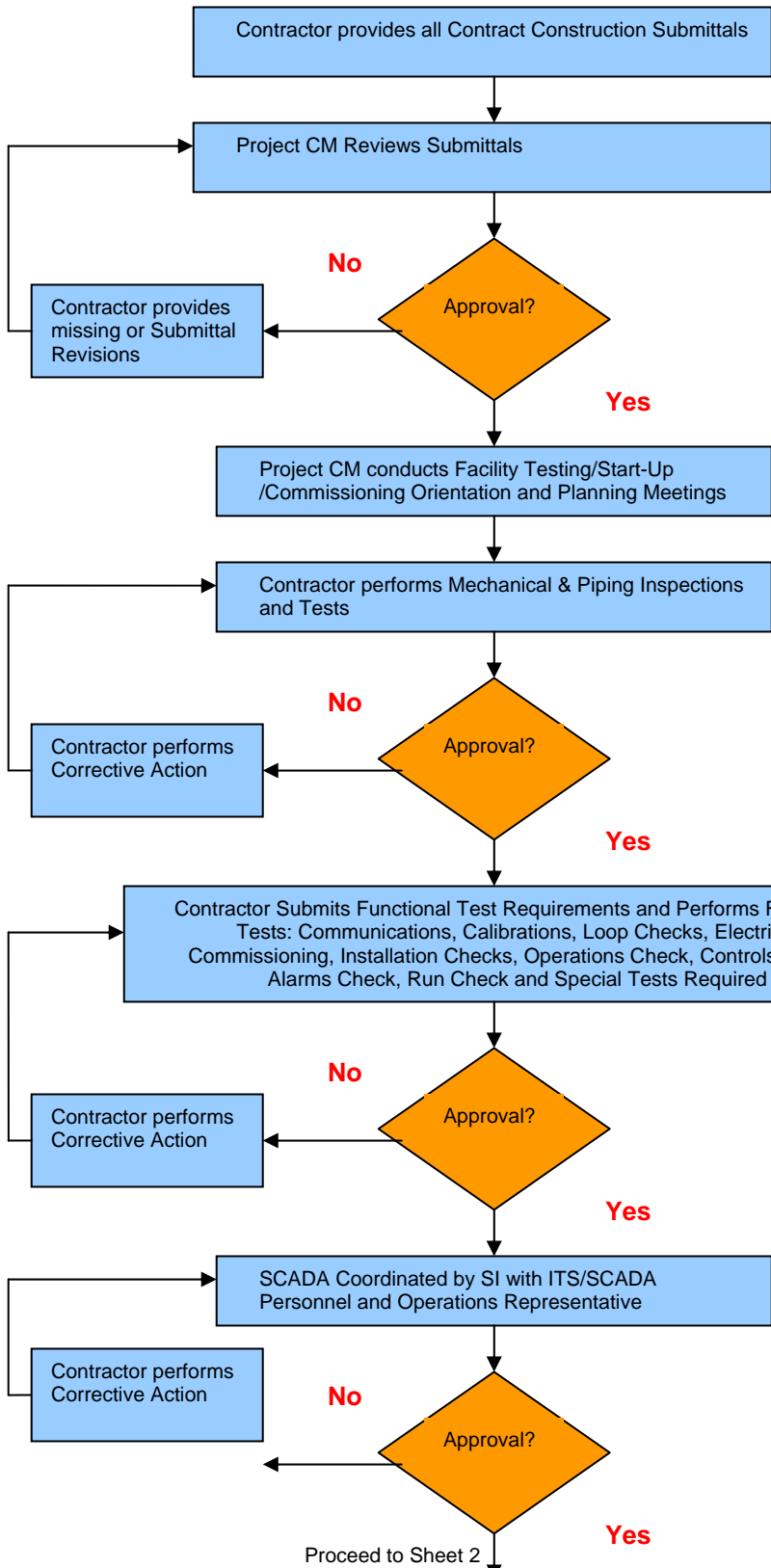
039 - 5      Documents Distribution List for CMP No. 039

039 - 6      Revision Control Log

**Attachment 039 - 1**  
**Typical System Testing and Start-Up Team Organization**  
**(City / CM Consultant / Contractor)**



**Attachment 039 – 2**  
**Page 1 of 2**  
**Typical System Testing and Start-Up Flow Diagram**



- Start-Up & Commissioning Team Typical**
- City Personnel**
1. Project Construction manager (CM)
  2. Project Engineer (PE)
  3. ITS/SCADS Specialist (ITS)
  4. Electrical & Controls Inspector (CMB/EMB)
  5. Operations Representative (OR)
- CM Consultant Personnel**
1. Test & Start-Up Lead Engineer
  2. Test & Start-Up Engineer(s) (T&SE)\*
  3. Electrical & Mechanical Inspector(s)\*
- Contractor Personnel**
1. Contractor Test Coordinator
  2. Electrical Testing Firm (ETF)
  3. System Integrator (SI)
  4. Communications/SCADA Specialist
  5. Electrical Subcontractor Support\*
- \*Support as needed
- Refer to Attachment 039-1 for complete personnel listing.

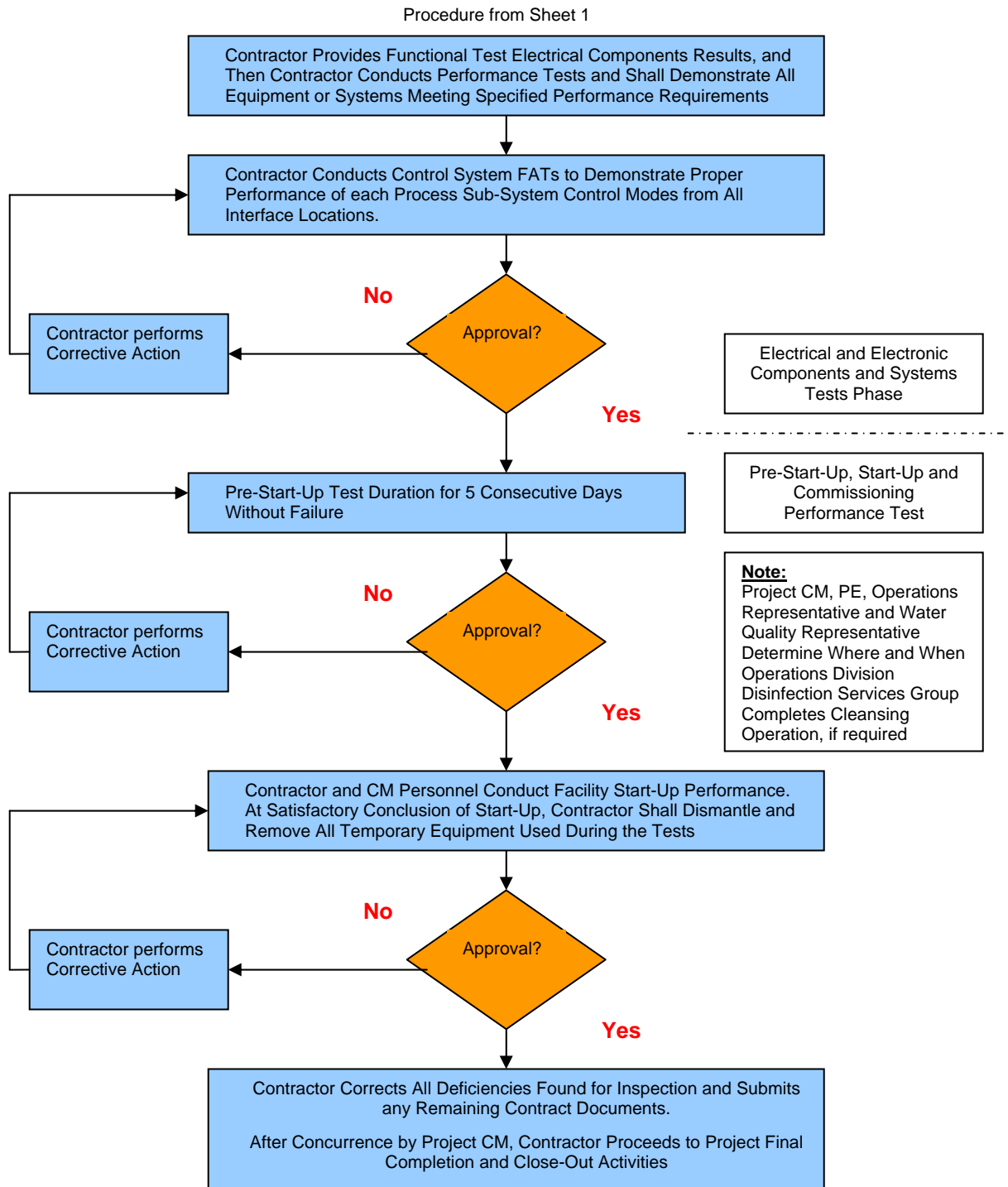
Pre-Electrical Systems Start-Up Activities Phase

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Electrical and Electronic Components and System Tests Phase Reference: Technical Specification No. 01660



**Attachment 039 – 2**  
**Page 2 of 2**  
**Typical System Testing and Start-Up Flow Diagram**



**Attachment 039 – 3**  
**Page 1 of 3**  
**Testing and Start-Up Submittal Forms and Records Summary**

A summary of major facility systems testing and start-up submittal forms and records are presented below. The complete testing and start-up requirements and their submittal documentations shall be in accordance with Technical Specification No. 01660, Testing Coordination and System Startup; and other references provided in this procedure for Quality Control, Data submittals and Manufacturer's support services.

Specific Test Data and Information required for submittal by Contractor are presented in Technical Specification No. 01660. Basic Test Information for each form should include the following:

- Date and Time of Test
- Test Participants: Names, Organization, Role
- Type of Test
- Purpose or Brief Test Description
- Estimated Duration and Actual Duration of Test
- Exceptions to Approved Test Plan, if applicable
- Reference to Test Change Notice, if applicable

## **I. MECHANICAL AND HYDROSTATIC PRESSURE TESTS**

Facility Mechanical and Hydrostatic Pressure Tests shall be completed and accepted by Project CM before starting Functional Testing, refer to Procedure Section 5.3.

1. Mechanical Tests, in-situ installation inspection and tests in accordance with applicable Technical Specifications; i.e. pumps, HVAC Systems, etc.
2. Valves and Piping Systems Hydrostatic Pressure Tests, in-situ installation inspection and tests in accordance with applicable Technical Specifications.

### Submittals for Post Mechanical and Hydrostatic Pressure Tests

- a. Contractor's Certification of Proper Installation and Readiness for Testing Sheet; i.e. mechanical, valves and pipes.
- b. Hydrostatic Pressure Test Diagram for Piping Systems; show boundary limits of hydrostatic test pressure in accordance with technical specification requirements.

## **II. FUNCTIONAL TEST REQUIREMENTS**

Functional Tests shall not proceed until the Project CM has received and approved the following items listed below;

1. Electrical Interconnection and Loop Diagrams
2. All factory test reports
3. Manufacturer's Certificate of Proper Installation (where required)

**Attachment 039 – 3**  
**Page 2 of 3**  
**Testing and Start-Up Submittal Forms and Records Summary**

4. Equipment or System Test Submittal
5. All specified Spare Parts and Special Tools
6. Draft Operations & Maintenance Manuals (Final O&M Manuals to have test results and data forms incorporated into them.)

Functional Tests shall be performed in accordance with Procedure Sections 5.4 and 5.5; and Technical Specification No. 01660.

Submittals for Post Functional Tests

- a. Test Log Summary and Test Forms
- b. Test Hold Log and Test Exceptions Log
- c. Test Change Notice
- d. Project Test Package Endorsement Record

**III. PERFORMANCE TEST REQUIREMENTS**

Performance Tests shall not proceed until the Functional Tests have been successfully completed and accepted by the Project CM.

Performance Test requirements shall be performed in accordance with Procedure Sections 5.6 and 5.7; and Technical Specification No. 01660.

Submittals for Test

- a. Test Log Summary and Test Forms
- b. Test Exceptions Log
- c. Test Change Notice
- d. Project Test Package Endorsement Record

**IV. PRE-START-UP AND START-UP TEST REQUIREMENTS**

The Pre-Start-up Test shall use the approved Start-up Test Procedure for the purposes of the Pre-Start-up Test. These tests verify the installation completion and systems operation mode.

The Start-up Test shall not proceed until the following have been completed;

1. All factory, functional and performance test records have been approved and available.
2. All draft O&M Manuals completed and approved.
3. City personnel trained in accordance with the individual technical specifications
4. All equipment, piping and systems component identities are tagged and labeled in accordance with contract documents.
5. All near final As-Built Drawings have been completed and approved.

**Attachment 039 – 3**  
**Page 3 of 3**  
**Testing and Start-Up Submittal Forms and Records Summary**

6. Start-up Test Procedure has been approved.

**V. PERFORMANCE TEST RUN**

The Performance Test Run is the verification step that the complete work functions on an extended basis as defined in scope and duration of the Contract, refer to Procedure Sections 5.10 and 5.11.

Submittals for Post Performance Test Run

- a. Start-up and Performance Log Summary
- b. Start-up and Performance Exceptions Log, if applicable
- c. Start-up and Performance Change Notice, if applicable
- d. Start-up and Performance Package Endorsement Record
- e. Final "As-Built" Drawings
- f. "As-Built" Programmable Logic
- g. Final Operations & Maintenance Manuals
- h. Equipment Warranties

**Attachment 039 – 4**  
**Page 1 of 2**  
**Facility Testing and Start-Up Plan**  
**Table of Contents Sample**

**1. Introduction**

Purpose  
General Over View

**2. Testing, Start-Up and Acceptance Plan Description**

Implementation

Testing – Hydraulic Transmission  
Testing – Mechanical Components  
Testing – Instruments, Electrical and SCADA  
Facility Start-Up  
Facility Performance Run

Definitions and Acceptance Criteria

Functional Test  
Performance Test  
Test Acceptance Criteria and Documentation  
Test Rejection Criteria and Documentation  
Retest for Acceptance Criteria and Documentation  
Notice of Substantial Completion  
Notice of Completion

**3. Roles and Responsibilities**

Contractor Start-Up Team (Names & Qualifications)  
Equipment & Materials Supplier Start-Up Assistance (Names & Qualifications)  
CM Consultant Team  
Owners (SFPUC) Team

**4. Scope of Work & Technical References**

Scope of Work

Equipment Testing based on Specifications & Manufacture's Procedure  
Transmission System and Piping Tests  
Components Testing  
Instrumentation & Electrical Systems Testing  
Automation Systems Testing with Owner  
System Testing  
Facility Testing  
Facility Start-Up  
Facility Performance Run

Contract and Technical References

Contract Specifications  
Manufactures' Guidelines for Installation and Start-Up  
Industry Practices, Methods and Guidelines

**Attachment 039 – 4**  
**Page 2 of 2**  
**Facility Testing and Start-Up Plan**  
**Table of Contents Sample**

5. **Other Work Requirements per Contract**
  - Safety – Emergency Contingency
  - Risk Analysis for Start-Up
  - Environmental – Emergency Contingency; SPCC Plan
  - Permits – Water Discharge / storm Water Control Plan
  - Permits – Air Discharge
  - Restricted Materials Handling Approval & MSDS
  - Waste Minimization and Recycle Plan
  
6. **Pre-Testing Submittals and Activities**
  - Testing and Start-Up Plan
  - Test Acceptance Form Format
  - Test Procedures & Methods
  - Facility Training Plan and Course Implementation
  - Draft Operations & Maintenance Manuals
  - Spare Parts List - Recommended
  - Contractor Secured Start-Up and Operating Permits
  - Agencies and Community Notifications
  
7. **Schedule**
  - Pre-Start-Up Activities
  - Equipment and Mechanical Tests
  - Transmission and Piping Tests
  - Component Tests
  - Instrumentation and Electrical Tests
  - Automation and SCADA Tests
  - System Tests
  - Start-Up
  - Performance Run
  - Demobilization
  
8. **Post Start-Up Deliverables**
  - Spare Parts List and Spare Parts
  - Equipment Warranties
  - As-Built Drawings Submittals
  - Final Operations & Maintenance Manuals
  - Certified Test Samples and Lab Analyses
  - Final Punch List with Corrective Actions Complete
  - All Acceptance Forms Signed
  
9. **Attachments**
  - Contractor Start-Up Team Organization Chart (Names & Positions)
  - Testing, Start-Up and Performance Run Schedule
  - Contractor Start-Up Team Check List (Detailed)
  - Work by Others - Draft List of Major Activities
  - SFPUC Owner/Operations
  - CM Consultant Team

**Attachment 039 – 5**  
**Documents Distribution List for CMP No. 039**

The following personnel listed (by project position or responsibility) for Documents Distribution is a general guideline for specific CM Procedure. It is the responsibility of the Administration / Document Control Specialist (ADCS) to confirm and as necessary revise this list as appropriate for the specific project needs. The Office Engineer shall approve these distribution changes.

The guideline for hard copy document distribution is follows:

1. Individual, without CMIS access, who attended a specific meeting
2. Individual, without CMIS access, who was mentioned or designated for action in a specific project meeting
3. Individual, without CMIS access, who has management oversight responsibilities to ensure the implementation or completion of project action.

**SPECIAL REPORTS:**

- **Notification of Facility Acceptance**
- **Final Start-Up and Test Report**

**DISTRIBUTION:**

**Project Field Personnel – Information Only, Not Distribution**

- Project CM, Field Contracts Administrator, Lead QA Inspector, Operations Representative

**Construction Management Bureau**

- Regional CM

**Program CM Consultant**

- Program CM Consultant Advisor
- Program QA Manager

**Project Management Bureau**

- Regional PM
- Project Manager

**Engineering Management Bureau**

- Project Engineer

**Attachment 039 - 6  
Revision Control Log**

Revision No.	Revision Date	What changed?
Rev 1	August 24, 2009	<ul style="list-style-type: none"> <li>• Added Section 3.1; CMIS</li> <li>• Added Section 3.6.1; SQS Information</li> <li>• Added Section 3.11.3; Approved Test Information</li> <li>• Revised Section 4.12; Sanitary Work Practices and Disinfection</li> <li>• Added Section 5.2.2.2; Confirmation of SES Exceptions</li> <li>• Consistency of text usage and formatting of entire document</li> <li>• Added new Section 7.0; added Sections 7.1, 7.2 and 7.3</li> <li>• Added new Attachment 4; Facility Testing and Start-Up Plan Table of Contents - <i>Sample</i></li> <li>• Added new Attachment 5; Documents Distribution List</li> <li>• Added new Attachment 6; Revision Control Log</li> </ul>
Rev 0	February 25, 2009	Signed